ELECTROGRAPHIC SENSOR FOR DETERMINING PLANAR COORDINATES

BACKGROUND OF THE INVENTION

There are many fields of technology wherein it is desirable to generate electrical signals which are proportional to some physical point in a planar coordinate system. For example, it is often desirable to accurately reconstruct graphs or other technical data representation, or to store the data in computers, tape storage, or the like. In other fields, it is often desired to "read" coded data contained on punched cards. These are typical applications of what generally may be classed as graphical data processing. In still another applicable field, continuous writing generates signals for reproducing this writing at some other location as in telautography.

Numerous devices have been devised that are acclaimed to solve individual of these and similar applications. One of the earlier of these devices is shown and described in U. S. Pat. No. 2,269,599 to H. C. Moodey. Another of the typical prior art single layer x-y position sensitive devices is that described in a booklet entitled "Information Display Concepts," distributed by Tektronics, Inc. (1968), and referred to as an "x-y tablet." Still another is the device described in U. S. Pat. No. 2,900,446 to D. J. McLaughlen, et al., In all of these devices, continuous electrodes are placed along each edge of a resistive sheet and various means are described for applying voltages between the electrodes to obtain the necessary orthogonal electrical fields. These same electrodes, however, cause severe distortion to the electrical fields during the time interval when they are not connected to the voltage supply. This restricts the use to only a small central region of the resistive sheet for accurate determinations of point coordinates.

The device described in U. S. Pat. No. 3,449,516 to S. H. Cameron, et al., is designed to reduce the field distortion caused by the continuous electrodes. Switching devices are used with each of several discontinuous electrodes to effect application of electric potentials to a resistive sheet. Each electrode is completely isolated from others when no voltage is being applied. Still another proposed solution to the problem of distortion is the device described in U. S. Pat. No. 3,591,718 to Shintaro Asano. In his device, the resistive sheet is framed with strips of a material having a lower resistivity than the sheet. The potentials for producing the electrical fields are applied to electrodes at the corners of the frame. The potential at any position along the edge, however, is affected by the quality of the contact between the strips and the sheet and the uniformity of the resistivity of the strips.

In addition to these single layer devices, there are known to be many multilayer graphical input tablets for generally accomplishing the desired results. Typical is the device disclosed in my copending patent application with J. E. Parks, Ser. No. 39,353, filed May 21, 1970.

None of the above-described devices, or others known to me, are universally applicable to all types of graphical data processing because of one or more deficiencies of accuracy, linearity, durability or simplicity.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic diagram of the most elementary form of my invention as utilized in a simplified circuit;

FIG. **2** is a drawing illustrating the preferred location of the electrodes shown in FIG. **1**;

FIG. **3** is a block diagram of a switching system utilized in my invention;

FIG. **4** is a schematic circuit diagram of a preferred switching arrangement for applying potentials to the resistor networks of FIG. **1**;

FIG. **5** is a schematic drawing illustrating an embodiment of my invention where the coordinates of a plurality of points are to be determined sequentially;

FIG. **6** is a cross sectional drawing of an embodiment of the invention for the continuous writing or tracing of information;

FIG. **7** is a cross sectional drawing of another form of construction of the embodiment of FIG. **6**;

FIG. **8** is a cross sectional drawing of a pressure-sensitive probe that may be used with all of the embodiments of the invention; and

FIG. **9** is a schematic drawing of a pressure-sensitive system for use with the embodiments of FIGS. **6** and **7**.

SUMMARY OF THE INVENTION

My invention in its simplest form utilizes a single rectangular sheet of resistive paper having a highly uniform electrical resistivity throughout which is provided with a row of a plurality of small individual electrodes along each edge and a small electrode in each corner, all electrodes being in electrical contact with the resistive paper. Discrete resistors are connected between adjacent electrodes in each row with resistor values depending on the configuration of the spot electrodes. Switching circuits are provided to apply a voltage between the electrodes of one row and the electrodes of the row along the opposite edge of the paper, and whereby a voltage may also be applied alternately, during a mutually exclusive time period, between the other two rows of electrodes on the other edges of the paper to produce orthogonal electric fields in the resistive paper. A moveable probe is provided to contact the paper at a selected point, or series of points, whereby a voltage signal is derived between the point of contact and a reference potential, that is accurately proportional to the *x*- and *y*-coordinates of the point or points. The contacting of the resistance paper takes place either through the probe itself or through a conductive sheet brought into contact with the resistive paper by the probe.

DETAILED DESCRIPTION

The underlying principle of my invention may be explained through the use of FIG. **1.** A uniform resistive sheet **10** is suitably mounted by any conventional means to a support (not shown) so as to form a flat plane. This resistive sheet may be, for example, distributive resistance paper, Type L, manufactured by Knowlton Bros., Watertown, N. Y., having a resistance of 1,000 to 2,000 ohms per square. For my use, I prefer paper having 2,000 ohms per square with highly uniform electrical resistivity throughout the sheet. In each corner of sheet **10** are spot electrodes **11** as at points A, B, C, and D. Spaced in between the corner spot electrodes, in a row-like manner, are edge spot electrodes